SOLAR CELL (CAPSTONE) RESEARCH

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IAN SELLERS

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HOW DO SOLAR CELLS WORK?

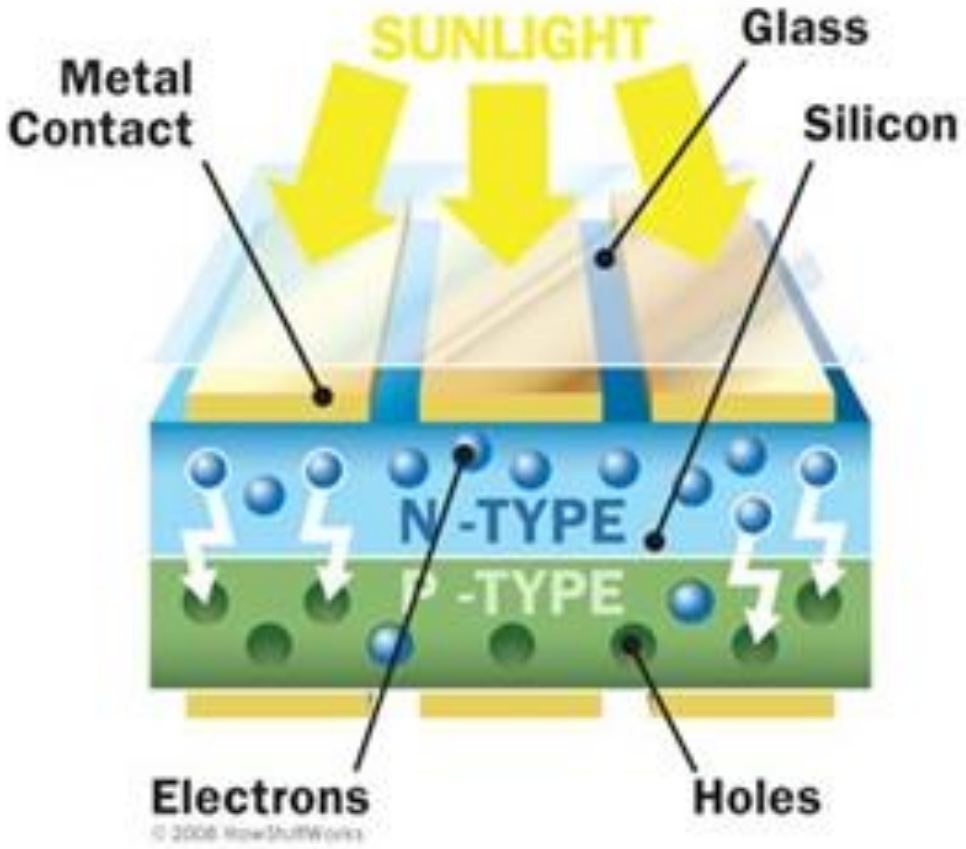
N-Type: excess of electrons and is a semiconductor layer

P-Type: lacking complete valence shell and is not as conductive

Sunlight enters and excites electrons out of their shells, creating a hole.

The extra electrons move to the top layer and the hole is filled in from the bottom.

There is an electric potential and the electrons can move from the top to the bottom by a wire (electricity).

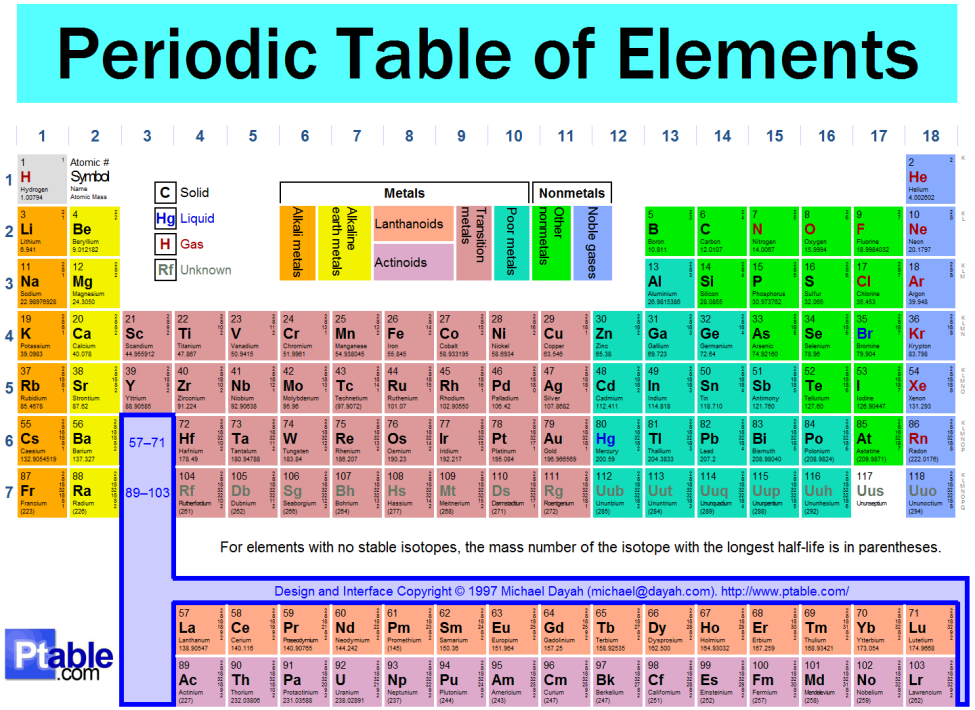


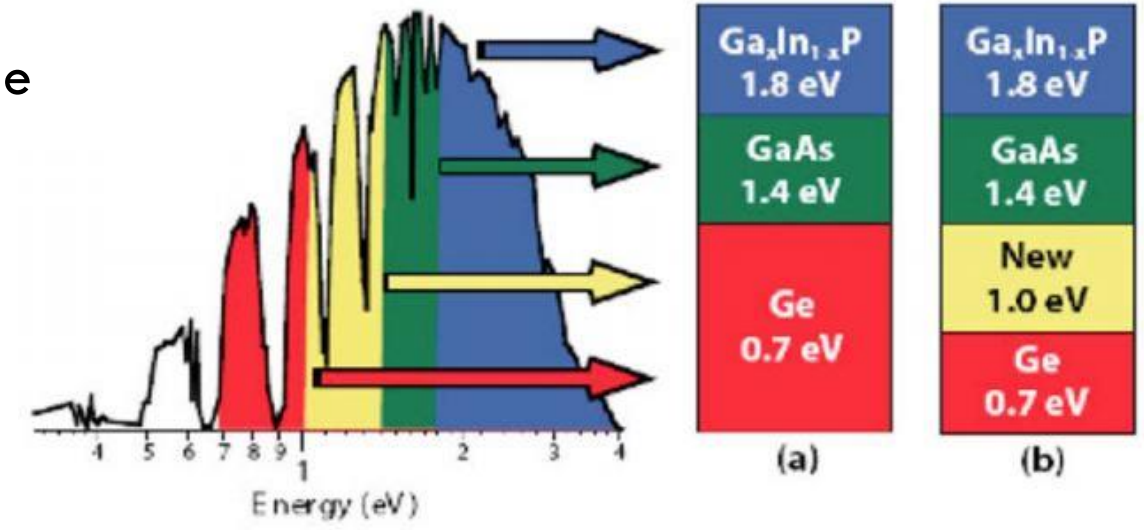
SIMPLE SOLAR CELLS

- Only absorb a small fraction of the solar spectrum (~25%)
- Work well for terrestrial and close orbit
- Doped silicon is a commonly used terrestrial solar cell
  - Substituting silicon cells with phosphorus creates a p-type layer
  - Substituting silicon cells with boron creates an n-type layer

MULTIJUNCTION SOLAR CELLS (MJSC)

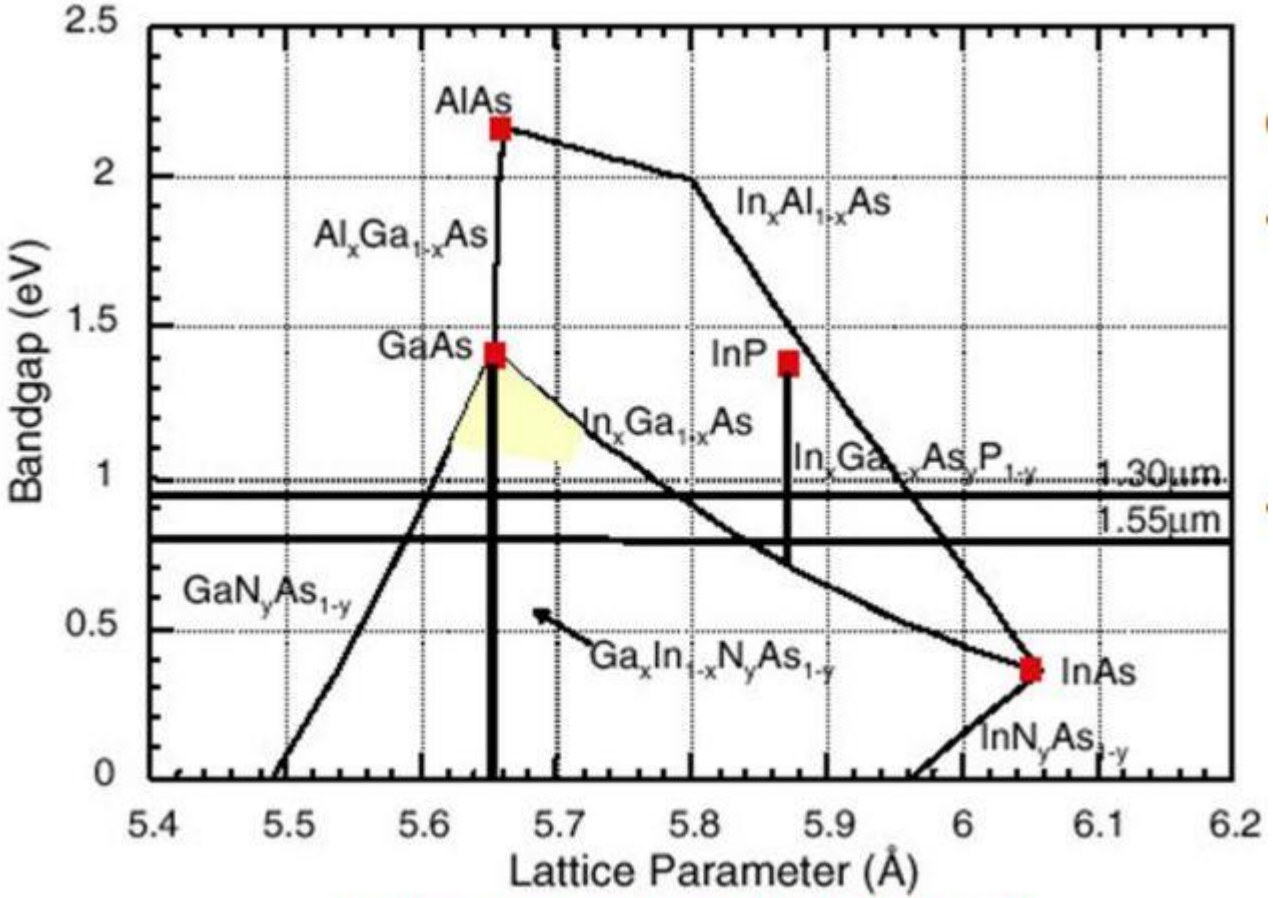
- III-V junction cells have best carrier/receiver properties
- Conventional MJSC efficiency is 27% and specific power is 500W/kg
- Conventional MJSC current limitations
- Proposed next-generation MJSC efficiency can be >39% and specific power of 2000W/kg





GALLIUM-INDIUM-NITROGEN-ARSENIC (DILUTE NITRIDE)

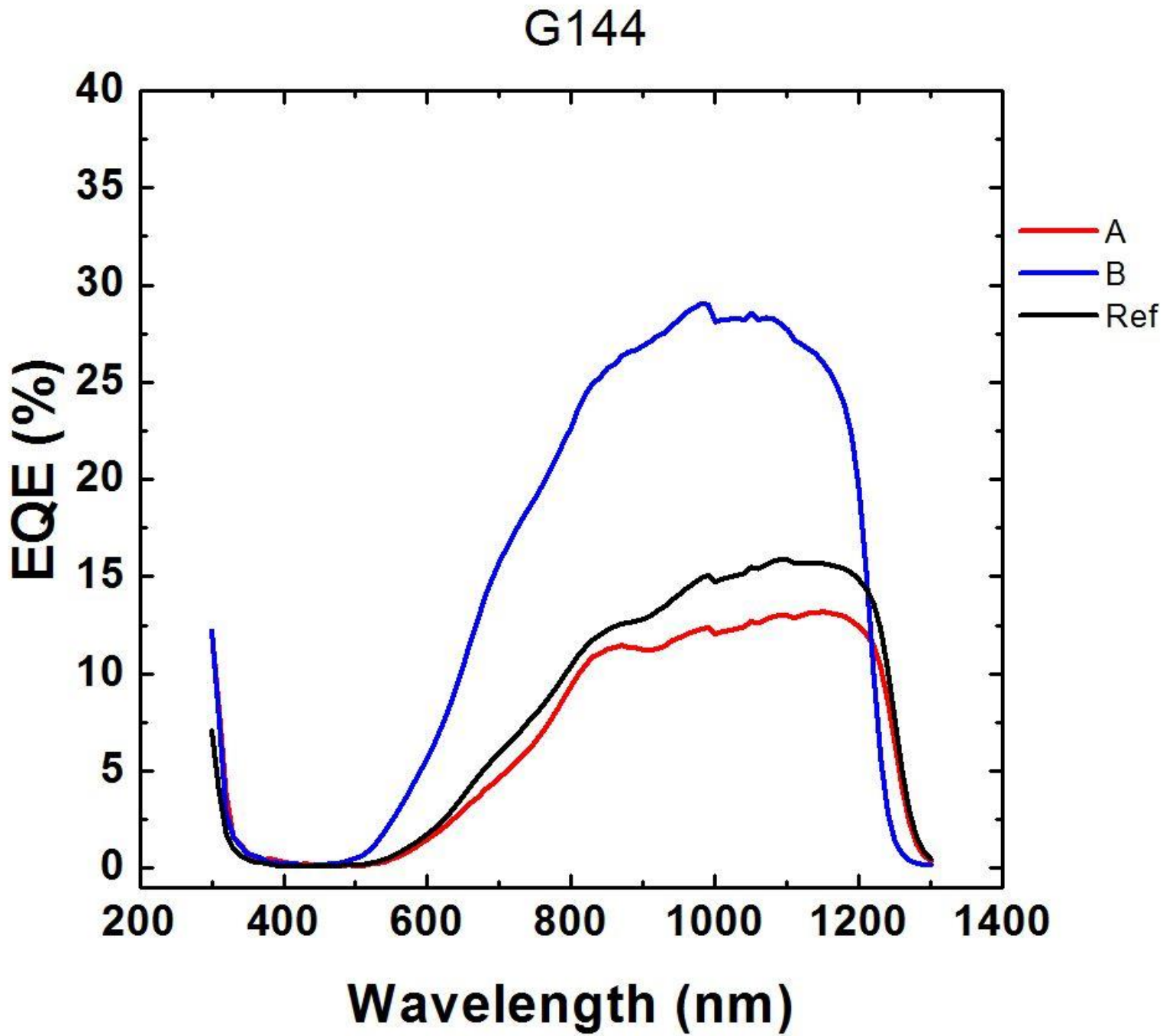
- Why?
  - Lattice matched (preserves material quality)
  - Current matched
- Why not?
  - High formation of defects and impurities
  - Low lifetime under extreme conditions



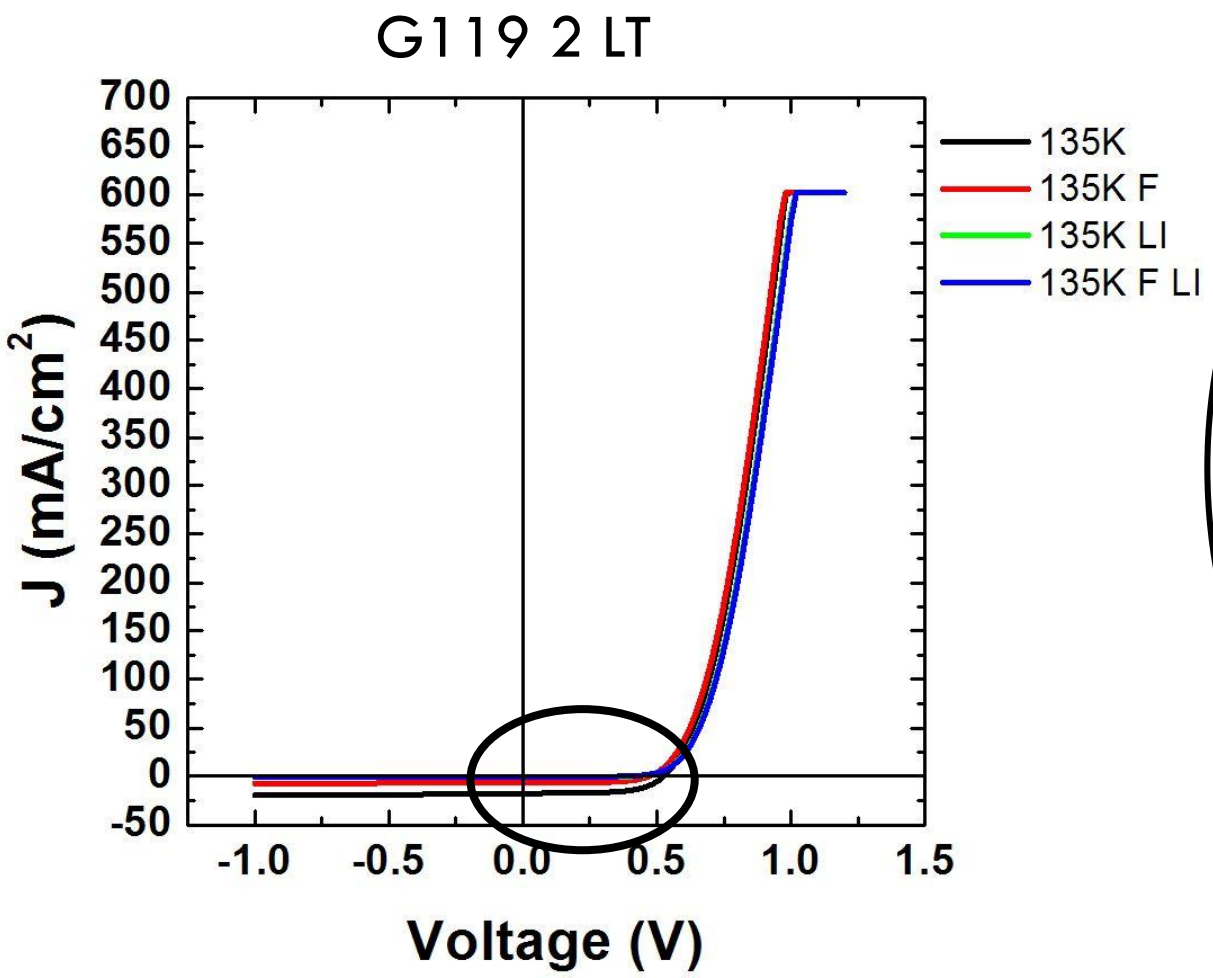
J. S. Harris, Semicond. Sci. Technol. 17, 880 (2002)

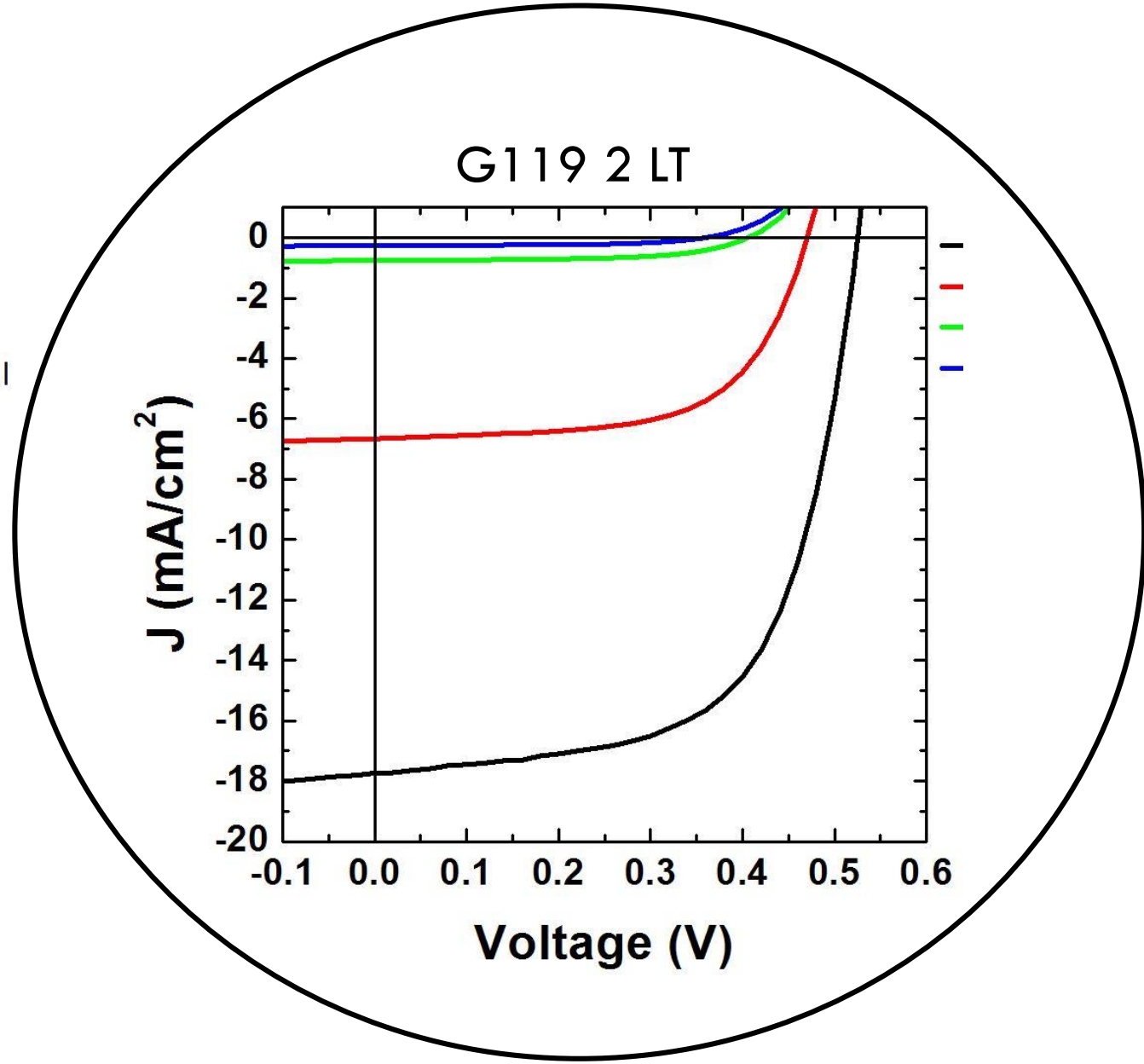
EXPERIMENT QUESTIONS

- Can hydrogenating GaInNAs cells increase their efficiency and lifetime?
- How should the cells be grown to have the best performance?
- Can this solar cell withstand space life at Low Intensity Low Temperature (LILT)?
- What happens to the sample after undergoing thermal cycling?
- What happens to the sample after radiation treatment?

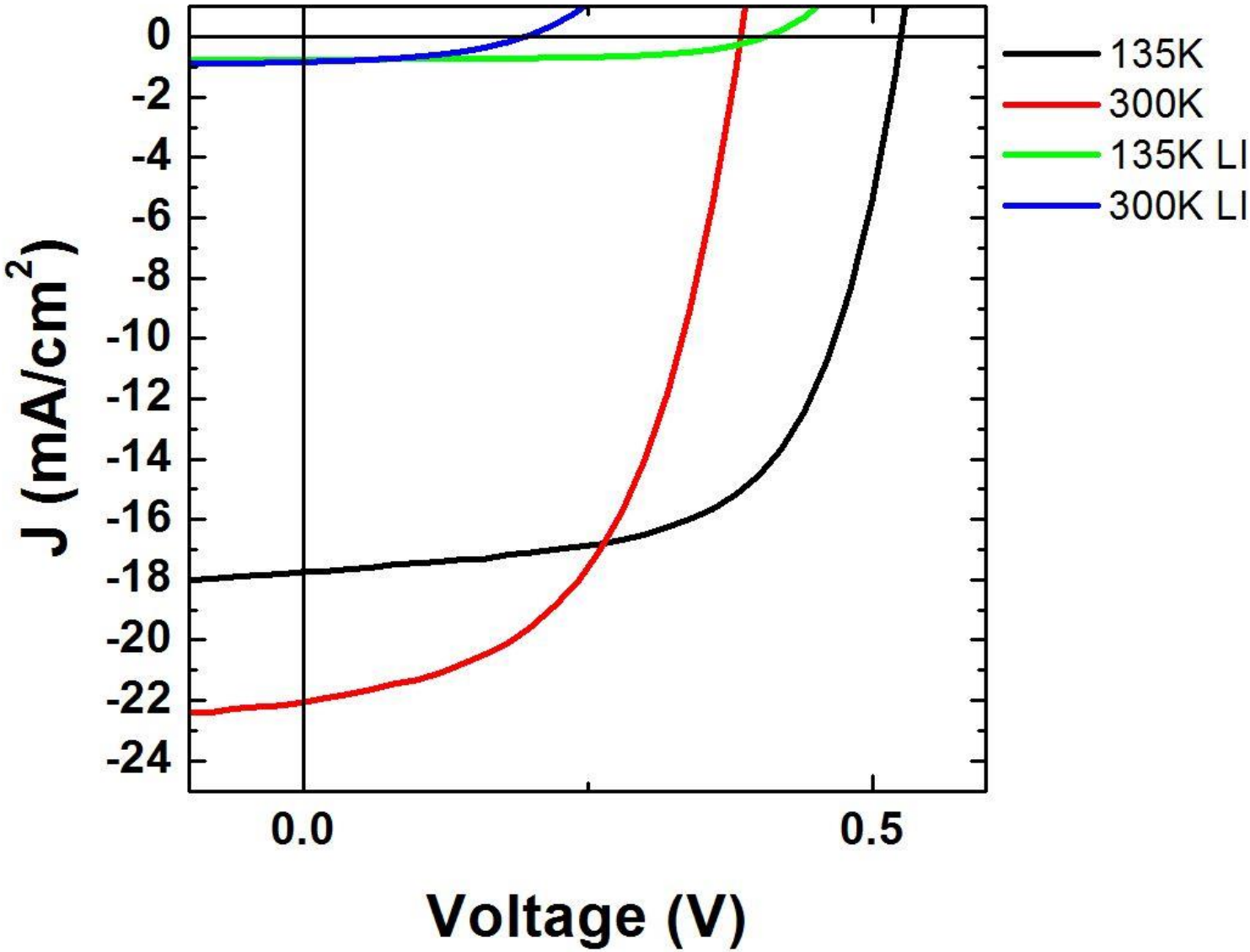

G144
EQE (%)
Wavelength (nm)
0
5
10
15
20
25
30
35
40
200
400
600
800
1000
1200
1400
A
B
Ref

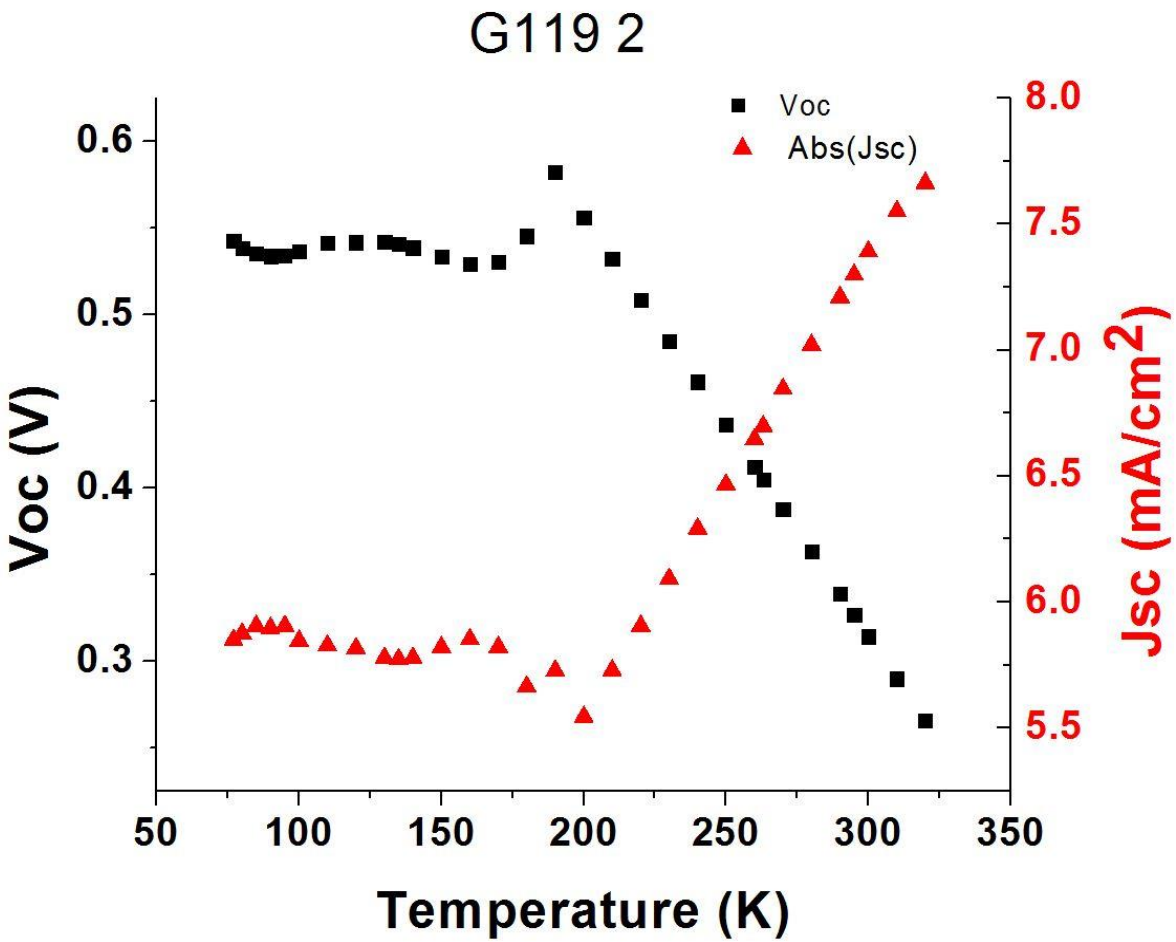
JV at Low Temperatures

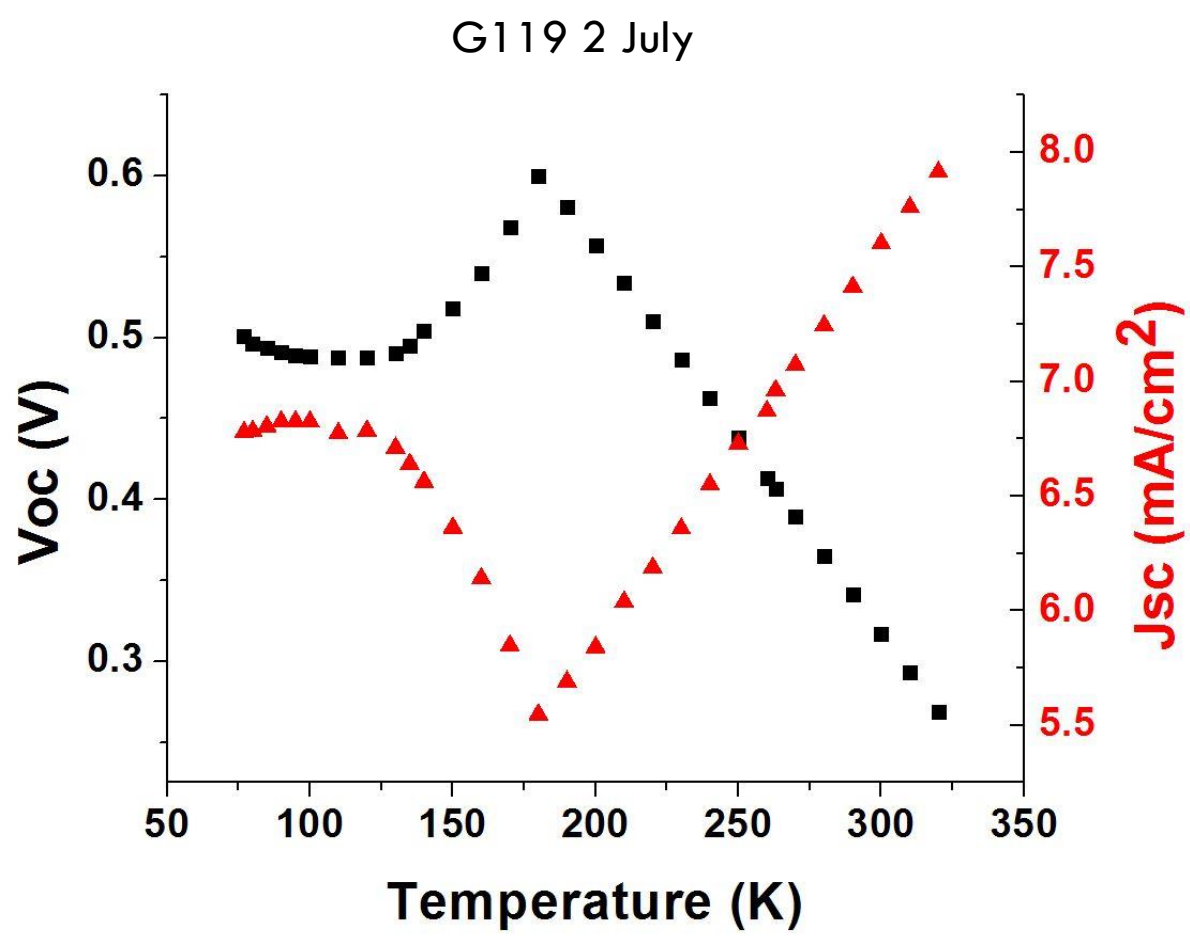




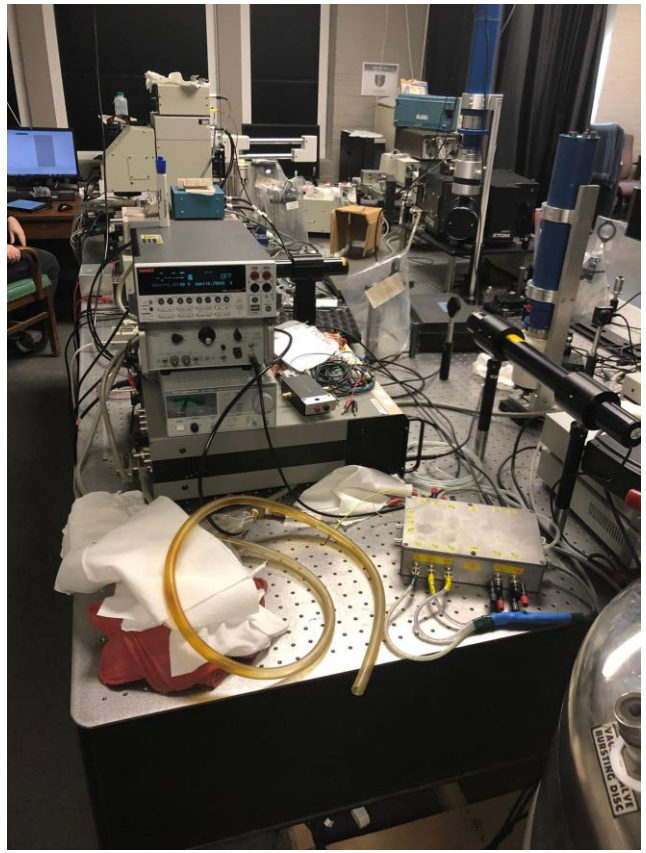
G119 2 No Filter




G119 2
Voc
Abs(Jsc)
Voc (V)
Jsc (mA/cm2)
Temperature (K)
0.6
0.5
0.4
0.3
8.0
7.5
7.0
6.5
6.0
5.5
50
100
150
200
250
300
350


G119 2 July
Voc (V)
Jsc (mA/cm2)
Temperature (K)
0.6
0.5
0.4
0.3
8.0
7.5
7.0
6.5
6.0
5.5
50
100
150
200
250
300
350

THE LAB



QUESTIONS?

Acknowledgements:

Ian Sellers

OU Physics Department

NASA

Google for the images